MRCS5 Electrical Specification

Maximum Motor Supply Voltage	12 V Nominal
Maximum Continuous Motor Current	20 A
Maximum Motor Stall Current [Short Term Only]	100 A
Control Circuit Supply [Derived from RC Receiver]	4.8 V to 6.0 V, Nominal 10 mA Maximum

Standard Club 500 Motor - Measured Performance

Motor as supplied by Club 500 Slipway

Measurement Conditions:

Motor Voltage	7.2 V
Propellor	40 mm diameter, two blade, standard

Measured Results

No Load Speed [With Propellor in Air]	14,100 rev/min
No Load Current	1.86 A
Stall Current	Approximately 75 A
Running Speed [With Propellor in Water]	11,700 rev/min
Running Current	Approximately 14 A

Note that motor performance in water was measured using a water test tank of dimensions 260 mm long x 200 mm wide x 100 mm deep, with the propeller position fixed within the tank—i.e no forward motion.

Timpdon Marine

Club 500 Radio Controlled Motor Controller Model *MRCS5*

Solid State Radio Controlled Motor Controller

Designed primarily for motor control of Club 500 Fast Electric Racing Boats, with forward motor rotation only, and no reverse.

Features

- For battery voltages up to 12 V d.c, nominal.
- Solid state 1 kHz PWM motor power controller rated at 20 A continuous.
- Short term motor stall currents up to 100 A.
- M3 bolted terminals for motor connections.
- Three user selectable **Operating** modes:
  - 0% / 100 % switched motor voltage
  - 0% / 50% / 100% switched motor voltage
  - 0% to 100% fully variable motor voltage
- Two user selectable **Joystick** modes:
  - Spring loaded centre off joystick
  - Full travel ratchet joystick
- Fail safe feature to de-energise motor if radio control is lost.
- Direct replacement for servo operated mechanical power switches.
- Dimensions: 30 mm wide [39 mm over terminals] x 41 mm high x 12 mm deep.

Contents

Freewheel Diode

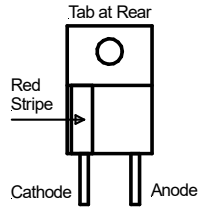
Because motor windings have inductance, as well as resistance, when the motor is de-energised, the motor inductance will attempt to keep the motor current flowing. This results in the motor developing across its terminals a voltage proportional to the rate at which the motor current is decaying, until the current reaches zero. On a high current motor, such as the **Club 500** motor, this can result in the generation of a very high voltage. If the motor is controlled by a mechanical switch, this high voltage may cause arcing which will reduce the switch life but, normally, have no other effect.

However, when the motor is controlled by an electronic switch, the voltage generated may well be above the maximum rating of the transistor or FET used to perform the switching action, possibly resulting in catastrophic permanent failure of the semi-conductor device.

To eliminate this problem, a freewheel diode is used. When the motor is energised this diode performs no function, but when the motor is de-energised, it allows the motor current present at the moment of switch off to circulate [freewheel] through the diode and motor whilst reducing smoothly at a controlled rate to zero, eliminating the voltage spike and thus protecting the switching device.

*On the **MRCS5**, the freewheel diode **must** be fitted. Failure to fit it will invalidate all warranties.*

The diode supplied should be fitted **directly** between the two motor terminals, with the **cathode**, marked in **Red**, connected to the motor **positive** terminal. The photograph below shows one recommended way of mounting this diode. If you need to extend the diode leads, make sure that the extension wire is rated for at least 10 A. Solid wire is recommended. Keep the leads as short as practicable however, as this will minimise radiated motor interference.



Freewheel Diode

Fail Safe

The ***MRCS5*** is fitted with an automatic fail safe to protect against loss of radio communication.

If no valid radio pulses are detected for a continuous period of 2.5 seconds, the motor will be de-energised automatically, and the **LED** will go **Off**.

Normal operation will resume as soon as radio communication is established again.

Note, however, that this feature will not work if your RC system already has a built in fail safe to reset the RC receiver output to a default output pulse width level in the event of loss of communication. This feature is often incorporated in 2.4 GHz systems.

*In this case, however, provided that the RC receiver fail safe is set to the pulse width level equivalent to **Off**, this will achieve the same effect.*

However, on some 2.4 GHz systems, on the loss of radio signals, the last detected output is maintained indefinitely, for at least some channels. In such cases, the fail safe system will not function and if radio communication fails with the motor energised all control will be lost with your boat possibly at full speed

- BE WARNED !!

Introduction

The ***MRCS5*** radio controlled motor power controller is primarily designed to be used in **Club 500** fast electric racing boats, but is suitable for any model designed for forward motion only, without reverse.

It is designed to be user selectable for transmitter channels controlled either by a **spring loaded centre off** joystick, or by a **full travel ratchet** joystick.

For **spring loaded** joysticks, the operating range in normal operation from **centre off** to **full forward** only.

For **ratchet** joysticks, the operating range is over the **full travel** of the joystick.

In both cases, the transmitter channel must be set such that **forward** joystick travel corresponds to **increasing** RC pulse width. This setting usually corresponds to transmitter channel servo direction switches set to **Normal**.

Automatic calibration of the zero speed joystick setting is incorporated for both joystick modes.

The ***MRCS5*** motor power output is PWM controlled at a frequency of 1 kHz and can be set to one of three user selectable operating modes:

Mode 1

The motor voltage is **switched** between **off** and **full** voltage, depending on the joystick setting.

Mode 2

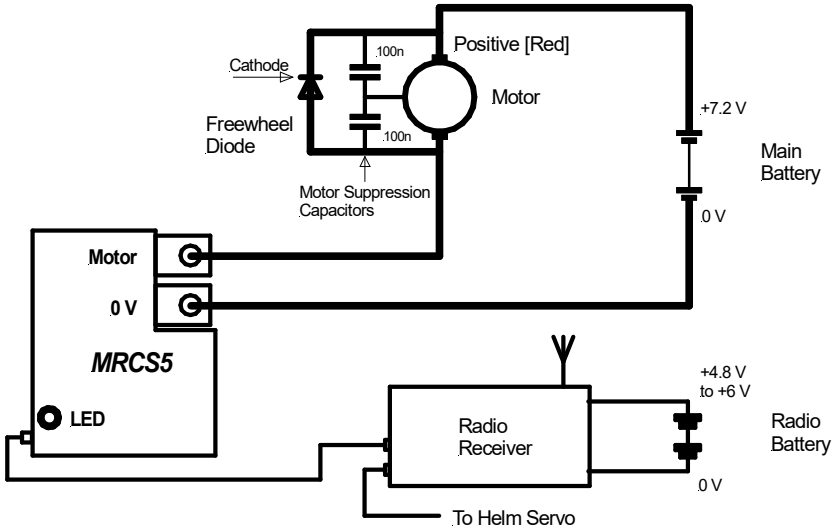
The motor voltage is **switched** between **off**, **50 %** of full voltage and **full** voltage, depending on the joystick setting.

Mode 3

The motor voltage is **linearly controlled** between **off** and **full** voltage, depending on the joystick setting.

In all modes**,** to minimise the shock applied to propeller shaft couplings, motor voltage **increases** are rate limited to 0.4 % of full voltage per ms, giving a minimum acceleration period from zero to full speed of 250 ms. Motor voltage **decreases** are instantaneous.

Wiring Diagram



Installation and Wiring

Read this Manual carefully and refer to the Wiring Diagram before starting.

1 First, connect the Freewheel Diode supplied directly across the motor terminals. The **Cathode** of the diode, marked **Red**, must be connected to the motor **positive** terminal, also usually marked **Red**. However, irrespective of the motor markings, the **Cathode** of the diode ***must*** be connected to the motor terminal connected to the **battery positive** terminal.

You must fit this diode. It protects the electronic switch from high voltages generated by the inductance of the motor windings when the motor is de-energised. See ***Freewheel Diode*** for additional advice.

2 Next, connect the two motor suppression capacitors supplied. Connect one 100 nF capacitor directly from each motor terminal to the metal body of the motor. If you gently file the motor body to remove oxide deposits, you can usually solder to it without much difficulty. Whilst these capacitors are not essential, their use is highly recommended to minimise the risk of erratic operation caused by motor interference.

LED Indications

The **LED** indicator on the ***MRCS5*** indicates a number of system operating conditions:

Start Up Period

For 7 seconds after power up, the ***MRCS5*** control system will perform no function, while waiting for the radio link to bind and stabilise.

During this period, the **LED** will **flash** rapidly.

Normal Operation With RC Pulses Detected

The **LED** will **flash** in a burst sequence of **zero** or **one long** flash, indicating **Joystick** Mode, followed by **one**, **two** or **three short** flashes, indicating **Operating** mode.

The sequence is repeated every 2.5 seconds.

No Long Flash	= Spring Loaded Centre Off joystick
One Long Flash	= Ratchet Joystick
One short Flash	= Operating Mode 1 0% / 100% Fixed Motor Voltage
Two Short Flashes	= Operating Mode 2 0% / 50% / 100% Fixed Motor Voltage
Three Short Flashes	= Operating Mode 3 0% to 100% Variable Motor Voltage

Programming Mode

During programming of either **Operating Mode** or **Joystick Mode**, the **LED** will go **Fully On**.

Loss of Radio Control

If valid radio pulses are not present at the end of the start up period, or if radio control is lost, and the fail safe function operates to de-energise the motor, the **LED** will go **Off**.

Operating Mode Programming

You can only program a new operating mode if the ***MRCS5*** is set for a **Spring Loaded Centre Off** joystick. If you are using a **Ratchet** joystick, change the joystick mode to **Spring Loaded Centre Off** before performing this programming operation, and then reset the joystick mode to **Ratchet** on completion.

The current **Operating Mode** may be programmed by the user at any time, Once set, the new mode is stored in non-volatile memory until changed again.

Programming Procedure

1 Turn the transmitter **On**.

2 Then turn the receiver **On**. The ***MRCS5*** **LED** will flash rapidly for seven seconds as the transmitter and receiver bind and stabilise.

3 **Before the end** of this period, set and hold the transmitter joystick at **Minimum**.

4 At the end of the stabilisation period, the **LED** will go fully **On**. Now set the joystick **Off.**

5 Then pulse the joystick from **Off** to **Maximum** to **Off**, **one**, **two** or **three** times, corresponding to the required **Operating Mode number ,** as described in ***Operating Modes***.

6 Once the required number of pulses has been completed, set the joystick to **Minimum**. The **LED** will extinguish.

7 Then release the joystick to the **Off** position.

The ***MRCS5*** will set and retain the new operating mode in non-volatile memory, and then perform a complete system restart as if power had just been applied, with the new operating mode operational.

Note

If you attempt to program a pulse count number other than **one**, **two** or **three** pulses, no change will be made to the previous operating mode.

Installation and Wiring

continued

3 Connect the motor **positive** [**Red**] terminal to the main battery supply **positive** terminal, via a suitable switch and/or fuse, if desired. Connect the motor **negative** terminal to the **Motor** terminal of the ***MRCS5***.

Connect the **0V** terminal of the ***MRCS5*** to the main battery supply **negative** [**0V]** terminal.

If, on testing, the motor rotates in the wrong direction, reverse the motor connections, taking note of the comments regarding the Freewheel Diode in **Step 1**, above.

Remember that the motor may take currents in excess of 10 A, so use cable rated for at least 15 A continuous. Keep wiring as short as possible and ensure that any connectors used are adequately rated. Bolted M3 ring crimp terminals are recommended for power connections to the ***MRCS5***. Two M3 ring crimp terminals are supplied. Although designed for crimp termination, if you first remove the terminal insulation, adequate joints can be made by soldering connecting wires to these terminals.

4 Connect the flying lead of the ***MRCS5*** to the required channel of the radio receiver. See ***Transmitter Joystick Operation and Calibration*** for additional advice.

*Note that the **0V** connection of the **radio battery** is internally connected to the **0V** connection of the **main** battery within the **MRCS5**.*

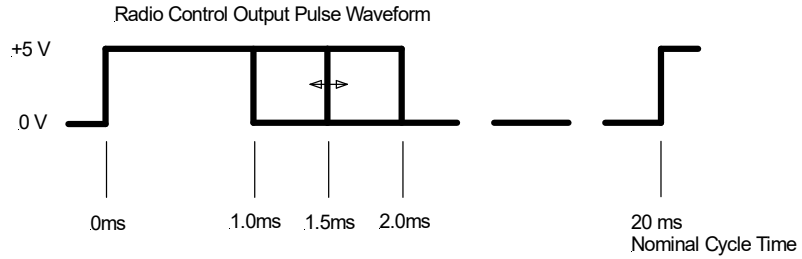
5 Installation is now complete.

Note:

You are recommended to determine the motor rotation direction and connect the freewheel diode, motor suppression capacitors and motor wiring on the bench, before fitting the motor into your boat.

Experience has shown that this method is much less likely to result in a wiring error than attempting to accomplish it inside the hull !

Transmitter Joystick Operation and Calibration



In a standard RC system, the output from each receiver channel is a variable width pulse, nominally between 1.0 ms and 2.0 ms in width, proportional to the position of the joystick, repeated at intervals of approximately 20 ms. Within the ***MRCS5***, control values for pulse widths within this range depend on the joystick mode, as follows:

	1.0 ms Minimum	**1.5 ms**	**2.0 ms Maximum**
Centre Off Joystick	Full Reverse	Off	Full Forward
Ratchet Joystick	Off		Full Forward

On most transmitters, the pulse widths corresponding to **maximum** and **minimum** joystick position can be reversed using the **normal/reverse** transmitter channel servo direction switches.

To accommodate transmitters with pulse width calibrations differing from the standard levels specified above, the ***MRCS5*** incorporates automatic calibration of the actual transmitter **Off** joystick setting, within the following pulse width ranges:

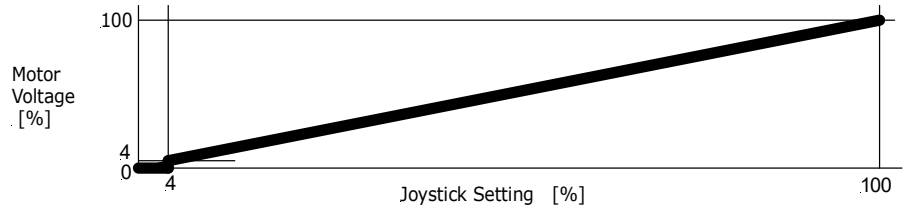
	Nominal	**Calibration Range**
Centre Off Joystick	1.50 ms	1.40 ms to 1.60 ms
Ratchet Joystick	1.00 ms	0.80 ms to 1.20 ms

For joystick **Off** settings outside these ranges, the ***MRCS5*** automatically sets the **Off** calibration to the **nominal** value shown in the table above.

Operating Modes

continued

Mode 3 — 0% to 100% Fully Variable Motor Voltage



Joystick Setting	**Action**
< 4%	Set motor voltage = zero [Dead Band]
> 4%	Set motor voltage equal to the Joystick setting

Note that motor voltage increases are rate limited to a maximum change of 0.4% of maximum motor voltage per ms.

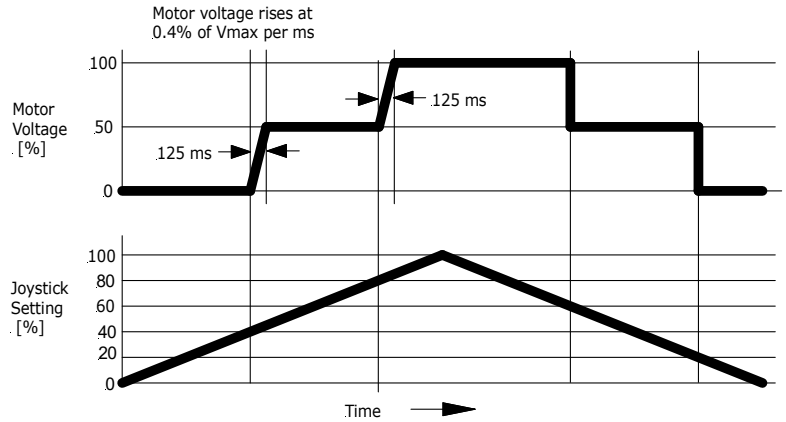
Motor voltage decreases are instantaneous.

This operating mode corresponds to that of a standard RC electronic speed controller.

Operating Modes

continued

Mode 2 0% / 50% / 100% Fixed Motor Voltage



Joystick Setting	Action
< 20%	Set motor voltage = zero
20% to 40 %	Take no action [Hysteresis]
40% to 60 %	Set Motor Voltage = 50 %
60% to 80 %	Take no action [Hysteresis]
> 80 %	Set motor voltage = 100%

Note that motor voltage increases are rate limited to a maximum change of 0.4% of maximum motor voltage per ms.

Motor voltage decreases are instantaneous.

Transmitter Joystick Operation and Calibration

continued

To permit automatic joystick **Off** position calibration, the following procedure **must** be followed at power up:

1 The transmitter joystick must first be set and held at the **Off** position.

2 The transmitter must be switched on **before** the receiver is switched on.

3 The joystick must not be moved until the **LED** on the ***MRCS5*** has stopped rapid flashing, following radio link stabilisation, and normal system operation commences.

At the end of this period, provided that the joystick pulse width is within the limits defined in the table above, the width of the first pulse detected by the ***MRCS5*** will be saved in non-volatile memory as the new **Off** setting, with a value dependent upon the current joystick mode. If this condition is not met, the **Off** calibration will be maintained at either the most recent previous valid calibration or, by default, at the **nominal** value for the current joystick mode.

Note that, at all times during normal system operation, the flash sequence on the ***MRCS5*** **LED** will show the current **joystick mode**, in addition to the current **operating mode**. See ***LED Indications*** for details.

Joystick Mode Programming

The ***MRCS5*** is shipped from the factory with the joystick mode set for a **spring loaded centre Off** joystick. You may change from the current joystick mode to the **opposite** mode at any time using the following procedure at power up:

1 First, turn the transmitter **On.**

2 Then turn the receiver **On**. The ***MRCS5*** **LED** will flash rapidly for seven seconds as the transmitter and receiver bind and stabilise.

3 **Before the end** of this period, set and hold the transmitter joystick at **Maximum**.

4 At the end of the stabilisation period, the **LED** will go fully **On**. Now set the joystick to the **Off** position corresponding to the new joystick mode.

The ***MRCS5*** will set and save the new joystick mode, and then perform a complete system restart and joystick **Off** calibration as if power had just been applied, with the new joystick mode operational.

Once set, the new joystick mode is saved in non-volatile memory and retained, until changed again.

Normal System Operating Procedure

1 First set the transmitter joystick to the **Off** position.

2 Turn the transmitter **On**.

3 Then turn the receiver **On**.

The **LED** on the ***MRCS5*** will flash for seven seconds while the control system waits for the radio link to bind and stabilise.

4 At the end of this period, the **LED** will start flashing in bursts of **one**, **two** or **three short** flashes, repeated every 2.5 seconds. The number of **short** flashes in each burst indicates the current operating mode. In addition, the flash sequence will also show an initial **long** flash if the joystick mode is set for a **Ratchet** joystick. See ***LED Indications*** for details.

One Flash	**Mode 1** 0% / 100% fixed motor voltage
Two Flashes	**Mode 2** 0% / 50% / 100% motor voltage
Three Flashes	**Mode 3** 0% to 100% fully variable motor voltage

5 The system is now ready for use.

Move the joystick from **Off** towards **Maximum** to energise the motor.

Move the joystick back to **Off** to de-energise the motor.

Notes

1 See ***Operating Modes*** for a detailed description of each mode.

2 See ***Operating Mode Programming*** for instructions on how to change to a different operating mode.

3 When shipped from the manufacturer, the ***MRCS5*** is factory pre-programmed to **Mode 1**.

4 If you power up the ***MRCS5*** with the transmitter off, no joystick **Off** calibration will be performed, the **LED** will not flash at the end of the start up sequence, and the motor will be held de-energised. Once the transmitter is energised, system operation will start normally, using the last valid joystick **Off** calibration.

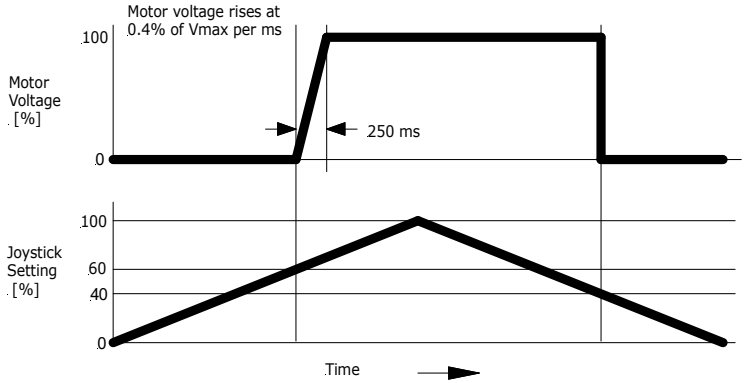
Operating Modes

The ***MRCS5*** has three user selectable operating modes, which may be changed by the user at any time, as described in ***Operating Mode Programming***.

Once programmed, the new mode is saved in non-volatile memory and retained until changed again.

In the graphs below, **0%** joystick setting corresponds to **Off** and **100%** corresponds to **Maximum**.

Mode 1 0% / 100% Fixed Motor Voltage



Joystick Setting	Action
< 40%	Set motor voltage = zero
40% to 60 %	Take no action [Hysteresis]
> 60 %	Set motor voltage = 100%

Note that motor voltage increases are rate limited to a maximum change of 0.4% of maximum motor voltage per ms.

Motor voltage decreases are instantaneous.